

Study of the large disturbance stability of an hybrid High Voltage AC and Multiterminal DC system

Research Groups

- L2EP (<https://l2ep.univ-lille.fr>)

Supervisors

- Xavier Guillaud (L2EP)
- Frédéric Colas (L2EP)

Introduction and general context

This PhD proposal is part of the PROSECCO European project which has been recently accepted. The studies related to PROSECCO is focused on the three following topics: DC protection relay testing and integration, AC protection near DC grids and optimal use of DC infrastructure through power flow control.

This proposition is focused on the item **AC protection near DC grids**:

Indeed, increased renewables and HVDC installations lead to increased utilization of power electronic converters in the power system.

Power electronic converters have a fundamentally different voltage-current behavior, during transients and short circuits. A particularly important problem is the issue of blinding (and mis-operation) of AC protection systems. At the same time, power electronic devices are expected to be increasingly supportive of the grid, for instance being grid forming during transients. Even if this behavior is not limited to HVDC stations or future MTDC grids, these installations are critical due to their size and must ensure that their operation does not jeopardize the system during any transient event.

This PhD will be focused on the study of MTDC grids connected to AC grids like the one illustrated in the Figure 1 and their impacts on the AC protection systems in case of DC faults.

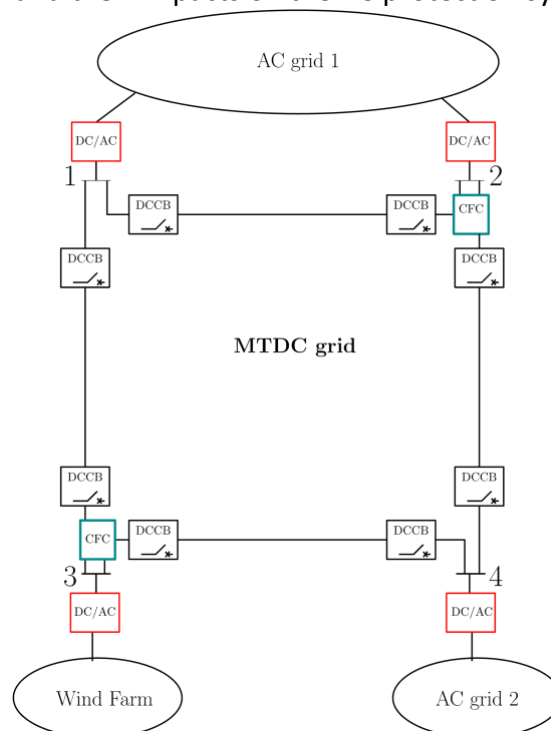


Figure 1 – MTDC grid connected to AC grids

PhD Objectives and planning

Main Objective:

The objective of the proposed PhD is to develop methodologies to understand and mitigate the impact of faults at the DC and AC side of converters. More precisely, this PhD will compare the impact on the AC protections of two different strategies for DC fault clearing:

1. Selective fault clearing: to open the faulty cable with powerful DC breakers able to extinguish large DC fault current with high under a large DC voltage.
2. Non-selective fault clearing: Progressive de-energization of the HVDC grid to disconnect the faulty cable with smaller circuit breaker or even DC switches. This supposes to use full bridge MMC able to limit the DC fault current contribution and operate at low DC voltage.

The PhD planning has been divided into 4 main Tasks:

1- Stability of MTDC grids with grid-forming controlled MMC:

The objective is to study the impact of MMC controlled in Grid-Forming mode on the stability of MTDC grids.

2- Small-signal stability analysis of AC/DC grid with grid-forming controlled HVDC stations:

The objective here is to make a small-signal stability analysis of power systems which integrate AC and DC grids. This small-signal stability analysis will be realized on the whole power system which includes both AC and DC dynamic behavior.

3- Comparison and Dynamic analysis of AC /DC grid in case of a selective or non-selective fault clearing of the HVDC grid:

The primary objective of this task is to systematically investigate the key dynamic phenomena that occur in a system comprising both AC and DC grid and subjected to a DC fault.

4- Impact on AC grid protections:

The goal of the task is to setup new signal processing algorithms combined with modification of HVDC converter controller settings to improve the detection and selective clearing of AC faults.

NB: The methodologies developed during this PhD will be supported by experimental validations made on the mock-up presented in Figure 2 which will be built in the prosecco project. It corresponds to an adaptation of an existing test-bench that allows to make test on low-voltage MTDC grid. The PhD student will collaborate with another researcher who will be in charge of the main experimental development.

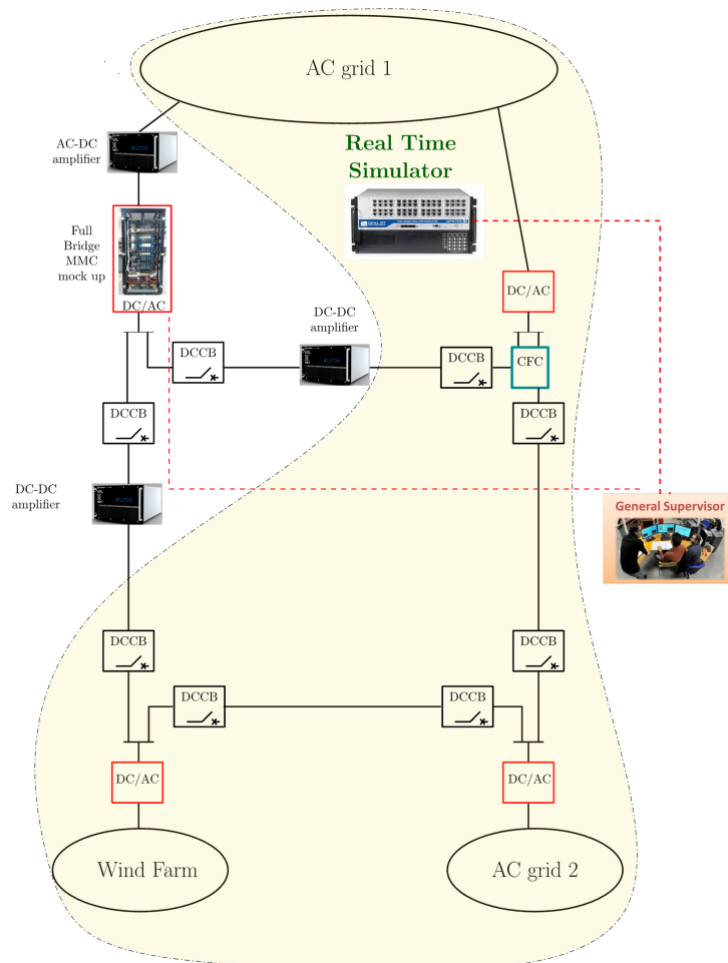


Figure 2 – Mock-up used to validate the methodologies designed in the proposed PhD

Requirements

As an ideal PhD candidate:

- You have a MSc with a relevant background in electric power systems or power electronic converters with application in power systems, preferably from a reputable institute from a country within the European Economic Area.
- You should have obtained excellent study results.
- You should have a keen interest to work in a team with experts studying different aspects of power electronics and power systems.
- You have experience with one or more of the following: power system dynamics, control design, power electronic converters, electrical networks
- You have excellent written and oral communication skills in English.

Localization and supervision

L2EP is a Laboratory of Electrical Engineering and Power electronic, located at Lille – France (<http://l2ep.univ-lille1.fr/>)

The research project is managed by professors Xavier Guillaud, Frederic Colas

How to apply?

Send the following elements by email to: phd.position@epmlab.eu

Selected candidates will be evaluated on technical skills and on their research capabilities (e.g. reviewing a paper):

- CV
- Cover letter
- Reference letters. At least one reference letter from your Master internship supervisor is necessary.
- Grades obtained during the master, and ranks.